SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING AUGUST, 1928

By HERBERT H. KIMBALL, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements the reader is referred to the REVIEW for January, 1924, **52**:42; January, 1925, **53**:29, and July, 1925, **53**:318.

Table 1 shows that solar radiation intensities averaged above normal values for August at all three stations.

Table 2 shows that the total solar radiation received on a horizontal surface directly from the sun and diffusely from the sky was above the August normal at Madison and Lincoln and below the normal at Washington.

Skylight polarization measurements made at Washington on seven days give a mean of 52 per cent, with a maximum of 54 per cent on the 13th. At Madison measurements made on seven days give a mean of 67 per cent with a maximum of 77 per cent on the 31st. These are close to the corresponding average values for August at Washington and considerably above at Madison.

TABLE 1.—*Solar radiation intensities during August, 1928*

[Gram-calories per minute per square centimeter of normal surface]

Date	Sun's zenith distance									
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	[1]1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Washington, D. C.											
Aug. 2	17.37				0.82	1.17					18.59
Aug. 3	17.37				0.88						19.89
Aug. 6	17.37				0.97	1.25					16.79
Aug. 13	10.59					1.41		1.03			9.14
Aug. 14	11.81	0.73	0.84	0.98	1.12	1.34	1.12				13.13
Aug. 18	18.59				0.66						18.59
Aug. 20	14.10	0.63	0.74	0.86	1.03						12.24
Aug. 21	12.68	0.59	0.68	0.79	0.90						14.10
Aug. 28	19.89				1.07						18.59
Aug. 29	19.23	0.48	0.56	0.65	0.80	1.07					20.57
Aug. 30	20.57		0.56	0.69	0.88	1.18					18.59
Means		0.61	0.68	0.79	0.91	1.24	(1.12)	(1.03)			
Departures		−0.03	+0.01	+0.05	−0.01	+0.01	+0.10	+0.15			
Madison, Wis.											
Aug. 10	16.20				1.07	1.42					14.10
Aug. 11	10.59				1.07	1.24					10.21
Aug. 13	11.38				1.13	1.35					12.24
Aug. 14	10.59				1.04	1.25					13.13
Aug. 18	11.38				1.15	1.36					11.38
Aug. 21	12.68					1.40	1.24				9.53
Aug. 22	9.83		0.94	1.05	1.18	1.40					9.14
Aug. 25	10.21			1.12	1.26						9.47
Aug. 30	12.24					1.43					10.21
Aug. 31	7.29			1.17	1.31	1.45					7.29
Means			(0.94)	1.11	1.15	1.37	(1.24)				
Departures			+0.10	+0.06	−0.04	+0.06	+0.17				
Lincoln, Nebr.											
Aug. 1	16.79		0.80	0.92	1.09	1.34	1.08				18.59
Aug. 2	16.79		0.81	0.94	1.10						18.59
Aug. 4	14.10		0.68	0.78	0.89						14.10
Aug. 6	16.20		0.71	0.88							17.96
Aug. 7	16.20					1.37	1.13	0.94	0.82	0.70	14.10
Aug. 8	15.11		0.87	0.96	1.14	1.29	1.02				17.37
Aug. 9	17.96	0.71	0.83	0.90	1.10	1.35					15.11
Aug. 10	16.79		0.59	0.81	0.97	1.19					17.96
Aug. 13	17.37	0.53	0.64	0.79	1.00	1.28					17.96
Aug. 15	17.37				0.89	1.12					16.20
Aug. 20	16.20					1.20	1.01				17.37
Aug. 21	12.24			0.99	1.18	1.29					10.59
Aug. 23	15.65							1.01	0.87	0.78	10.21
Aug. 24	6.50				1.32	1.46	1.28	1.12	0.99	0.89	6.02
Aug. 25	8.81	0.85	0.94	1.04	1.22	1.34					10.59
Aug. 27	13.13					1.33	1.04	0.80	0.70	0.60	14.60
Aug. 29	16.79					1.21	1.12	1.04	0.96	0.84	18.59
Aug. 30	8.18		0.98	1.14	1.26	1.39	1.14	0.95	0.82	0.71	10.59
Means		0.70	0.78	0.92	1.10	1.30	1.10	0.98	0.86	0.75	
Departures		+0.04	+0.00	+0.02	+0.02	±0.00	+0.03	+0.09	+0.10	+0.05	

[1] Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning—	Average daily radiation						Average daily departure from normal		
	Washington	Madison	Lincoln	Chicago	New York	Twin Falls	Washington	Madison	Lincoln
1928	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
July 30	469	373	470	299	399	637	+28	−88	−55
Aug. 6	324	554	614	434	203	739	−113	+98	+108
Aug. 13	423	500	500	411	373	753	−2	+61	+13
Aug. 20	383	424	524	332	222	666	−22	−11	+28
Aug. 27	376	402	450	344	307	677	−37	−6	−5
Deficiency since first of year on Sept. 2							−800	−319	−1,766

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. C. S. Freeman, Superintendent U. S. Naval Observatory]

[Data furnished by Naval Observatory, in cooperation with Harvard, Yerkes, and Mount Wilson Observatories]

[The differences of longitude are measured from central meridian, positive west. The north latitudes are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1928	*H. m.*	°	°	°			
Aug. 1 (Naval Observatory).	11 48	−82.0	46.4	+5.5	123		
		−30.0	98.4	+7.0		139	
		−30.0	98.4	−25.5	31		
		−24.5	103.9	−17.0		93	
		−18.5	109.9	+10.5		46	
		+7.0	135.4	+14.0		340	
		+14.0	142.4	+13.5		432	
		+17.5	145.9	−20.0		31	
		+23.5	151.9	−20.0	22		
		+38.5	166.9	+6.0	31		
		+44.5	172.9	+5.5		62	
		+79.0	207.4	+13.5	123		1,473
Aug. 2 (Naval Observatory).	12 6	−75.5	39.5	+8.5	369		
		−68.0	47.0	+5.5	108		
		−41.0	74.0	−3.5	31		
		−20.0	95.0	+6.0	22		
		−18.0	97.0	−25.5	15		
		−15.5	99.5	+7.5		154	
		−11.0	104.0	−17.5		154	
		−3.0	112.0	+10.5	31		
		+22.5	137.5	+13.5		309	
		+28.0	143.0	+13.0	370		
		+38.0	153.0	−20.0	22		
		+57.5	172.5	+5.5		93	1,618
Aug. 3 (Naval Observatory).	11 29	−62.5	39.6	+8.5	340		
		−55.0	47.1	+5.5	62		
		−29.0	73.1	−3.5		46	
		−5.5	96.6	−25.5	9		
		−1.0	101.1	+8.0		154	
		+2.0	104.1	−17.0		123	
		+10.0	112.1	+10.5	15		
		+33.0	135.1	+14.5		154	
		+40.0	142.1	−19.5		93	
		+41.0	143.1	+13.0	370		
		+70.0	172.1	+5.0		62	1,428
Aug. 4 (Naval Observatory).	11 3	−75.0	14.1	+14.5	46		
		−73.5	15.6	−14.0		62	
		−65.5	23.6	−13.5	31		
		−49.5	39.6	+8.5	247		
		−42.0	47.1	+5.5	40		
		−40.5	48.6	−11.0	6		
		−16.0	73.1	−3.5		46	
		+11.0	100.1	+8.0		154	
		+15.0	104.1	−17.0		46	
		+22.0	111.1	+10.5		18	
		+47.0	136.1	+14.0		123	
		+52.5	141.6	−18.5		62	
		+53.5	142.6	+13.0	370		1,251
Aug. 5 (Naval Observatory).	11 29	−61.5	14.1	+14.5	31		
		−60.0	15.6	−15.0		46	
		−54.0	21.6	−14.0		77	
		−36.0	39.6	+8.5	247		
		−27.5	48.1	+5.5	40		
		+27.0	102.6	+7.5		93	
		+38.5	114.1	+10.0	9		
		+62.0	137.6	+14.0		123	
		+69.5	145.1	+13.0	340		1,006

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1928—Continued	H. m.	°	°	°			
Aug. 6 (Naval Observatory).	11 38	−46.5	15.8	−17.0		216	
		−39.5	22.8	−14.5		31	
		−22.0	40.3	+8.5	247		
		−14.5	47.8	+5.5	37		
		+32.0	94.3	−14.5		56	
		+39.5	101.8	+6.5		46	
		+50.0	112.3	+10.0		15	
		+82.0	144.3	+13.0	370		1,018
Aug. 7 (Naval Observatory).	12 46	−6.5	42.0	−19.0		77	
		−33.0	15.5	−18.0		216	
		−28.5	20.0	−15.5		154	
		−13.0	35.5	+10.5	9		
		−8.5	40.0	+8.5	201		
		−8.5	40.0	+12.0		31	
		0.0	48.5	+5.5	31		
		+21.0	69.5	+9.5		9	
		+65.0	113.5	+10.0	46		774
Aug. 8 (Naval Observatory).	11 25	−52.5	343.5	−19.0		62	
		−21.0	15.0	−18.5		216	
		−18.0	18.0	−16.0		62	
		−13.5	22.5	−15.5		185	
		−1.5	34.5	+19.5		46	
		+4.5	40.5	+8.5	154		
		+12.0	48.0	+5.5	31		
		+48.0	84.0	+31.0	3		
		+59.0	95.0	−15.0		12	
		+61.0	97.0	−13.5	15		786
Aug. 9 (Naval Observatory).	11 33	−87.0	295.7	+3.5	154		
		−39.5	343.2	−18.5		46	
		−8.5	14.2	−19.0		154	
		−3.5	19.2	−16.0		123	
		+1.0	23.7	−15.5	154		
		+13.0	35.7	+19.5		15	
		+18.0	40.7	+8.5	154		
		+26.5	49.2	+6.0	15		
		+63.5	86.2	+30.0		6	
		+69.0	91.7	−15.5	15		
		+74.0	96.7	−13.5	25		861
Aug. 10 (Naval Observatory).	11 35	−72.5	297.0	+3.5	216		
		−70.0	299.5	−20.0	31		
		−44.0	325.5	+22.5		15	
		−30.0	339.5	−19.5	9		
		−25.5	344.0	−19.0		31	
		+5.0	14.5	−18.5		185	
		+11.5	21.0	−16.0		123	
		+15.5	25.0	−15.5	185		
		+31.0	40.5	+8.5	170		965
Aug. 11 (Mount Wilson)	13 0	−60.0	295.5	+4.0	201		
		−55.0	300.5	−19.0		21	
		−10.0	345.5	−19.0	15		
		+25.0	20.5	−18.0		428	
		+46.0	41.5	+8.0	207		872
Aug. 12 (Mount Wilson).	14 15	−58.0	283.6	+8.0		39	
		−46.0	295.6	+5.0	188		
		−45.0	296.6	+22.0		25	
		−43.0	298.6	−18.0		30	
		+5.0	346.6	−18.0		10	
		+39.0	20.6	−18.0		418	
		+60.0	41.6	+8.0	237		947
Aug. 13 (Naval Observatory).	11 59	−47.5	282.1	+8.0		123	
		−43.0	286.6	+7.0		93	
		−40.0	289.6	−20.0		31	
		−35.5	294.1	+21.0	31		
		−32.5	297.1	+3.5	170		
		−32.0	297.6	−17.5		46	
		−30.5	299.1	+19.5	31		
		−27.5	302.1	−18.5		46	
		+17.0	346.6	−18.5	6		
		+34.0	3.6	−14.0	15		
		+45.0	14.6	−18.5		216	
		+56.5	26.1	−16.0		185	
		+71.0	40.6	+8.5	185		1,178
Aug. 14 (Naval Observatory).	11 38	−56.0	260.6	+9.0	22		
		−34.0	282.6	+8.0		77	
		−30.0	286.6	+7.0	93		
		−21.5	295.1	+22.0	9		
		−19.5	297.1	+3.5	170		
		−18.5	298.1	+19.5		31	
		−13.0	303.6	−18.0		25	
		+49.0	5.6	−16.0	46		
		+57.5	14.1	−18.5		123	
		+69.0	25.6	−16.0	185		
		+84.0	40.6	+8.5	154		935
Aug. 15 (Naval Observatory).	11 18	−74.0	229.5	−15.0	31		
		−42.5	261.0	+9.0	15		
		−22.0	281.5	+10.0		62	
		−17.0	286.5	+7.5		108	
		−6.5	297.0	+3.5		123	
		−5.5	298.0	+19.0	9		
		+0.5	304.0	−18.0		40	
		+33.5	337.0	−16.0		22	
		+57.7	1.0	−14.5	93		
		+62.5	6.0	−15.0	108		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1928—Continued	H. m.	°	°	°			
Aug. 16 (Mount Wilson).	14 0	−62.0	226.9	−16.0		247	
		−10.0	278.9	+18.0		5	
		−3.0	285.9	+7.0		52	
		+3.0	291.9	+12.0	5		
		+5.0	293.9	+20.0		9	
		+9.0	297.9	+4.0		175	
		+17.0	305.9	−18.0		10	
		+18.0	306.9	+17.0		5	
		+26.0	314.9	+18.0	4		
		+55.0	343.9	−19.0		19	
		+80.0	8.9	[−15.0]		196	727
Aug. 17 (Naval Observatory).	13 57	−52.0	223.6	−13.0		40	
		−49.5	226.1	−19.0		15	
		−49.5	226.1	−10.5	62		
		−45.0	230.6	−15.0		62	
		+10.5	286.1	+7.0		52	
		+22.5	298.1	+3.5		123	
		+29.5	305.1	−18.0	12		366
Aug. 18 (Naval Observatory).	11 2	−83.0	181.0	+5.0	216		
		−40.0	224.0	−13.0		62	
		−38.0	226.0	−18.5		25	
		−36.0	228.0	−11.5		77	
		−32.5	231.5	−15.0		46	
		+22.0	286.0	+7.0		31	
		+34.0	298.0	+3.5		123	
		+41.0	305.0	−18.0	12		592
Aug. 19 (Naval Observatory).	11 28	−84.0	166.6	−10.0	154		
		−70.0	180.6	+5.0	247		
		−25.0	225.6	−19.0	25		
		−24.5	226.1	−12.0		108	
		−19.5	231.1	−14.5	15		
		+48.0	298.6	+3.0	62		611
Aug. 20 (Naval Observatory).	11 40	−70.5	166.8	−10.0	170		
		−57.0	180.3	+4.5	247		
		−12.0	225.3	−12.0		370	
		−9.5	227.8	−19.0		154	
		−5.5	231.8	−14.5	15		
		+61.0	298.3	+2.5	123		1,079
Aug. 21 (Naval Observatory).	11 38	−81.0	143.1	+14.5	216		
		−75.0	149.1	−20.0		185	
		−64.5	159.6	−8.5	62		
		−58.0	166.1	−9.5	185		
		−42.5	181.6	+4.5	216		
		−3.0	221.1	+23.5	9		
		+2.0	226.1	−12.5		494	
		+4.0	228.1	−18.5		93	
		+8.5	232.6	−14.5		6	
		+74.5	298.6	+3.0	123		1,589
Aug. 22 (Naval Observatory).	11 45	−82.5	128.3	+18.0		154	
		−70.0	140.8	−21.0		93	
		−68.0	142.8	+14.5	185		
		−62.0	148.8	−20.5		123	
		−53.0	157.8	−8.5		62	
		−44.5	166.3	−9.5	123		
		−29.0	181.8	+4.5		201	
		−17.5	193.3	+30.0	18		
		+15.5	226.3	−12.5		463	
		+17.0	227.8	−18.5		154	
		+20.5	231.3	−15.0		6	1,582
Aug. 23 (Naval Observatory).	12 0	−71.0	126.4	+17.5		278	
		−57.5	139.9	−21.0		93	
		−54.5	142.9	+14.5	216		
		−47.0	150.4	−20.5	139		
		−38.0	159.4	−8.5	46		
		−30.5	166.9	−9.5	123		
		−16.0	181.4	+4.5		185	
		−4.0	193.4	+30.0	9		
		+26.5	223.9	−13.5		340	
		+31.0	228.4	−18.0		185	
		+31.5	228.9	−10.5	278		1,892
Aug. 24 (Naval Observatory).	11 35	−81.0	103.4	+4.5	93		
		−59.5	124.9	+18.0		154	
		−56.0	128.4	+17.0	309		
		−44.0	140.4	−20.5		77	
		−41.5	142.9	+14.5	247		
		−33.0	151.4	−21.0		185	
		−18.0	166.4	−9.5	123		
		−2.5	181.9	+4.5		108	
		+40.0	224.4	−14.0		309	
		+43.5	227.9	−17.5		154	
		+44.0	228.4	−12.0	370		2,129
Aug. 25 (Naval Observatory).	13 9	−72.0	98.4	−15.5		154	
		−67.0	103.4	+4.5	108		
		−43.5	126.9	+17.5		494	
		−28.0	142.4	+15.0	154		
		−19.0	151.4	−21.0	139		
		−3.5	166.9	−10.0		93	
		+10.0	180.4	+3.5		62	
		+13.5	183.9	+5.0	46		
		+54.0	224.4	−14.0		401	
		+59.0	229.4	−11.0	340		
		+59.5	229.9	−17.0		123	2,114

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1928—Continued	H. m.	°	°	°			
Aug. 26 (Mount Wilson).	11 0	−60.0	98.3	−15.0		55	
		−56.0	102.3	+5.0	134		
		−31.0	127.3	+18.0		319	
		−18.0	140.3	−16.0		16	
		−16.0	142.3	+15.0	322		
		−8.0	150.3	−22.0	172		
		+8.0	166.3	−10.0		13	
		+22.0	180.3	+5.0		17	
		+64.0	222.3	−14.0		218	
		+72.0	230.3	−7.0	372		1,638
Aug. 27 (Naval Observatory).	13 14	−68.0	75.9	+23.0		123	
		−44.0	99.9	−15.0		93	
		−40.0	103.9	+4.5	123		
		−19.5	124.4	+19.0		278	
		−16.0	127.9	+17.5		93	
		−13.0	130.9	+17.0	139		
		−2.0	141.9	−15.0		31	
		−1.0	142.9	+14.5	123		
		+7.0	150.9	−21.0	108		
		+22.5	166.4	−10.0	31		
		+40.5	184.4	+5.0	31		
		+82.0	225.9	−13.0		463	1,636
Aug. 28 (Naval Observatory).	11 38	−86.0	45.6	+9.0	93		
		−39.0	92.6	−9.5		15	
		−31.5	100.1	−15.5		62	
		−28.0	103.6	+4.5	139		
		−27.5	104.1	−14.0		31	
		−7.0	124.6	+18.0		278	
		−1.5	130.1	+16.0	216		
		+11.0	142.6	+14.5	170		
		+19.0	150.6	−21.0	154		
		+35.5	167.1	−10.0	22		
		+52.5	184.1	+5.0	31		1,211
Aug. 29 (Naval Observatory).	11 41	−80.0	38.3	+20.0	62		
		−72.5	45.8	+8.0	123		
		−70.0	48.3	+18.0	31		
		−18.0	100.3	−15.5		31	
		−13.5	104.8	+5.0	93		
		−13.0	105.3	−14.0		31	
		+7.0	125.3	+18.0		185	
		+22.0	140.3	+16.0	216		
		+24.5	142.8	+14.5	154		
		+31.5	149.8	−21.0	139		
		+49.5	167.8	−10.0	9		1,074
Aug. 30 (Naval Observatory.)	11 39	−67.0	38.1	+20.0	46		
		−59.5	45.6	+8.0	108		
		−57.0	48.1	+18.0	31		
		−4.0	101.1	−15.0		22	
		0.0	105.1	+5.0		93	
		+2.0	107.1	−13.5		31	
		+20.0	125.1	+18.5		93	
		+25.5	130.6	+15.5	185		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1928—Continued	H. m.	°	°	°			
Aug. 30 (Naval Observatory)—Continued.	11 39	+37.5	142.6	−17.0		31	
		+38.0	143.1	+14.5	154		
		+45.0	150.1	−21.5	108		902
Aug. 31 (Mount Wilson).	12 45	−48.0	43.3	+19.0		19	
		−45.0	46.3	+8.0	133		
		+15.0	106.3	+6.0	94		
		+38.0	129.3	+17.0		202	
		+52.0	143.3	+15.0	237		
		+60.0	151.3	−21.0	8		693
Mean daily area for August							1,147
July 23 (Mount Wilson).	9 30	−81.0	167.7	+7.0		21	
		−44.0	204.7	+14.0		169	
		−38.0	210.7	−20.0		42	
		+35.0	283.7	+5.0		70	
		+45.0	293.7	−20.0		40	
		+50.0	298.7	+9.0		423	
		+75.0	323.7	−22.0		36	801

PROVISIONAL SUNSPOT RELATIVE NUMBERS FOR AUGUST, 1928

(Data furnished by Prof. A. Wolfer, University of Zurich, Switzerland)

August	Relative numbers	August	Relative numbers	August	Relative numbers
1	107	11	73	21	71
2	116	12	74	22	79
3	126	13	90	23	101
4	100	14	89	24	91
5	80	15	73	25	104
6	67	16	76	26	112
7	79	17	58	27	110
8	59	18	41	28	
9	59	19	53	29	
10	80	20	58	30	84
				31	80

Number of observations, 29: mean, 82.4.

AEROLOGICAL OBSERVATIONS

BY L. T. SAMUELS

Free-air temperature departures for the month were of only moderate magnitude in practically all cases, being negative in the lower levels at all stations and positive in the higher levels at Broken Arrow, Due West, and Royal Center. (See Table 1.)

It will be noted that positive relative humidity departures occurred with positive temperature departures at a number of upper levels at Broken Arrow and Due West and negative relative humidity departures with negative temperature departures at Groesbeck. It is of interest to note in this connection the exceptionally heavy total monthly rainfall at Broken Arrow (10.11 inches) and Due West (13.90 inches) and the extremely light precipitation at Groesbeck (0.01 inch).

As might be expected, in these cases, the monthly mean free-air vapor pressures were greatly in excess of their normal at Broken Arrow and Due West and below normal at Groesbeck.

The resultant free-air winds for the month were in general close to normal. (See Table 2.)

The wind velocity at Sheridan, Wyo., on the 21st increased from a calm at the surface to 50 m. p. s. at 10 km., the maximum altitude. The direction remained west above 1 km. This observation was taken to the west of the center of a high-pressure area and as might be expected from such a strong wind a very marked change in the pressure distribution occurred during the following 24 hours. The high moved rapidly eastward and was replaced by an extensive depression. A pilot balloon observation made on the 22d at Cheyenne in the southern part of this low revealed a rapid increase in the wind from 7 meters per second at the ground to 42 meters per second at 3 km. The direction was west-southwest throughout.

An observation made at Knoxville on the 9th, at which time a tropical hurricane was centered over Tampa, Fla., indicated a northerly wind up to 2,500 meters superim-